trol film CoCrPt are obtained even when the vertical positions of the magnetic control film and the free layer are aligned with each other and, therefore, a bias magnetic field is not appropriately applied to the free layer.

[0102] **FIG. 11** shows waveform profiles of X-ray diffractiometry for CoCrPt/Cr thin films when the oxidation conditions of the NiTa amorphous film are changed. **FIG. 11** shows diffraction waveforms in X-ray diffractiometry in which the waveforms of the NiTa thin film and the substrate are formed by subtraction as a difference so that the diffraction peaks for the CoCrPt/Cr thin film become distinct. The ordinate is in an arbitrary unit. The following can be seen. The crystallographic orientation of the CoCrPt/Cr thin film on the NiTa amorphous film shows Co(00.2)/Cr(110) orientation with no oxidation (State A3 in **FIG. 6**). The orientation intensity is once weakened as oxidation proceeds, X-ray Co(00.2)/Cr(110) orientation disappears under the conditions of oxidation for 30 sec (State B in **FIG. 6**). In addition, Co(11.0)/Cr(200) orientation is provided as the oxidation proceeds further (State C in **FIG. 6**). When oxidation proceeds further to atmospheric exposure, the degree of Co(11.0)/Cr(200) orientation (State C in **FIG. 6**) is weakened. To recognize the crystal state under the oxidation condition for 30 sec, the polycrystal state of the film was observed by TEM and, as a result, it has been found that this is a polycrystal state and the crystal grain size is 14 to 16 nm. It has also been found that the grain size decreases as the oxidation proceeds. Accordingly, it is probable that the state of the crystal orientation under the oxidation condition for 30 sec is not a polycrystal thin film having a specified crystallographic orientation relative to the film plane but an isometric polycrystal state.

[0103] In other words, by changing the oxidation conditions of the NiTa amorphous surface, the crystallographic orientation of the CoCrPt/Cr thin film can be changed from Co(00.2)/Cr(110) orientation (State A' in **FIG. 6**) to Co(11.0)/Cr(200) orientation (State C in **FIG. 6**), between which a polycrystal state of orientation isometric relative to the film plane is present as a transition state both for Co orientation and Cr orientation. The experiment described above shows that the magnetic domain control bias magnetic field can be applied most appropriately to the free layer **7** in a case of the isometric orientation. In view of other experiments, it has been found that the CoCrPt/Cr orientation may also be Co(10.0), Co(00.2), Co(11.0) mixed orientation/Cr(110), Cr(200) mixed orientation and that the Co alloy magnetic domain control film having no particular crystal orientation mainly has better magnetic domain control film properties.

TABLE 2

		Content of Samples of NiTa Amorphous Film Investigated for Oxidation Conditions				
		Ion beam etching Layer	NiTa amorphous layer		Cr under-layer	CoCrPt
Sample #	Sample type	position for end point	Film thickness (nm)	Oxidation condition	Film thickness (nm)	Film thickness (nm)
1	No NiTa film	MnPt layer 2.5 nm	none	none	5 nm	10 nm
2	No oxidation for NiTa surface	↑	5 nm	↑	↑	↑
3	30 sec oxidation for NiTa surface	↑	5 nm	30 sec	↑	↑
4	150 sec oxidation for NiTa surface	↑	5 nm	150 sec	↑	↑
5	Atmospheric exposure for NiTa	↑	5 nm	about 60 sec in atmos-phere	↑	↑
6	No underlayer	↑	none	none	none	↑
7	Existent structure	Al_2O_3 2.5 nm	↑	↑	5 nm	↑

[0104] Usually, it is considered that an intense bias magnetic field can be obtained when the direction of C axis having the crystal magnetic anisotropy of Co crystals is directed to the direction of the magnetic field. The result of the experiments, however, shows that when the C axis is oriented within the film plane, Vhc increases, thus increasing variations. It is estimated that even when the heights of the free layer and the magnetic domain control film are aligned with each other as shown in **FIG. 4**(*a*), (*b*), the top end of the magnetic domain control film decreases in thickness and takes a shape overhanging on the free layer, and the dispersed scattering in the magnetization state at the top end increases by orientation of the C axis within the film plane, which increases Vhc. Alternatively, it is estimated that the crystal orientation within the film plane of the Co polycrystal thin film at the top end of the magnetic domain control film is dispersed and, when the C axis is oriented within the plane of the film, dispersed scattering in the magnetization state increases through the crystal grains at the top end, which increases Vhc. In the current technique,